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March 30, 2004
Date of Signature

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR LETTERS PATENT

Process And System For Making Shaped Snack Products

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ATTORNEY'S DOCKET NO. MWT 04-01

Field of the Invention

This invention relates generally to snack products, and particularly to a process and system for making shaped snack products.

Background of the Invention

Sheeted snack products are made by cutting dough pieces from a dough sheet, and then frying, baking or otherwise cooking the cut dough pieces. Examples of this type of snack product include "DORITOS" manufactured by Frito-Lay Inc., "PRINGLES" manufactured by the Proctor & Gamble Company, and "GOLDFISH" manufactured by Pepperidge Farms Inc.

In a high volume fabrication process, a cutter cuts each dough piece in a required size and shape from a continuous sheet of dough. Dough pieces for snack products which have a certain geometric shape, such as triangles and rectangles, can be cut from the dough sheet without producing any scrap dough. However, dough pieces for snack products having other shapes, such as ovals and animal forms, produce scrap dough, which is referred to in the industry as "web scrap". Although the web scrap can be recycled into new dough sheets, it is desirable to produce as little web scrap as possible during cutting of the dough pieces.

Another consideration during the cutting step is the separation of the dough pieces from the web scrap. Dough pieces for snack products which are small and have intricate features, are more difficult to separate from the web scrap than dough pieces for larger featureless snack products. In general, intricate features produce multiple connecting points with the web scrap, which can prevent separation of the dough pieces from the web scrap. These intricate features can also break during separation, causing the snack products to have inconsistent shapes.

Closely spaced dough pieces can also be difficult to separate from the web scrap. In this case, only thin strands of web scrap separate adjacent dough pieces. These thin strands can flex, preventing separation of the dough pieces, or can move with the dough pieces and tear away from the web scrap.

The present invention is directed to a process and system for making shaped snack products in which cut dough pieces are separated from a dough sheet in an efficient manner and with a minimum of web scrap. In addition, the process and system can be used to produce snack products having a unique appearance, structure and texture.

Summary of the Invention

In accordance with the present invention, a process and a system for making shaped snack products are provided. Also provided are shaped snack products fabricated using the process.

The process, simply stated, includes the steps of: providing a dough sheet; cutting dough pieces in the dough sheet separated by a web scrap; and then separating the dough pieces from the web scrap. The separating step can be performed by directing a pressurized gas stream at the dough pieces, while moving the dough pieces, and moving the web scrap at an angle relative to the dough pieces.

The system includes a cutter assembly configured to cut the dough sheet into a plurality of separate dough pieces having one or more selected shapes. In an illustrative embodiment, the cutter assembly includes a rotating cylindrical cutter mechanism operably associated with a rotating back up roller. In addition, the cutter mechanism includes multiple cutting segments comprising shaped blades having cutting edges configured to shape and seal the cut edges of the dough pieces. The system also includes a gas discharge system configured to direct

separate gas streams at the dough pieces contained in the cutting segments. In addition, the system includes a web scrap mechanism configured to move and orient the web scrap relative to the dough pieces, as the gas streams are directed at the dough pieces held in the cutting segments.

In an illustrative embodiment, the snack product comprises a multi-layered fried chip having a continuous shaped and sealed peripheral edge, and a hollow interior chamber. With a multi layered dough the peripheral edge has a double thickness, and provides a rigid peripheral support structure for the snack product and features thereof.

Brief Description of the Drawings

Figure 1A is a schematic cross sectional view of a system for making snack products in accordance with the invention and with the system shown in a first position;

Figure 1B is a schematic cross sectional view of the system and with the system shown in a second position;

Figure 2A is an enlarged portion of Figure 1B illustrating a cutter and a web scrap conveyor of the system during separation of dough pieces from a web scrap;

Figure 2B is a plan view of a portion of the web scrap taken along line 2B of Figure 2A;

Figure 2C is a plan view of a dough piece (rabbit) taken along line 2C of Figure 2A;

Figure 2D is a plan view of a dough piece (duck) taken along line 2D of Figure 2A;

Figure 2E is a plan view of a dough piece (bird) taken along line 2E of Figure 2A;

Figure 2F is a plan view of a dough piece (cat) taken along line 2F of Figure 2A;

Figure 2G is an enlarged cross sectional view of a dough sheet taken along line 2G of Figure 2A;

Figure 3A is a schematic side elevation view of a cutter mechanism of the system;

Figure 3B is a schematic cross sectional view of the cutter mechanism taken along line 3B-3B of Figure 3A illustrating a ring and a mandrel thereof;

Figure 3C is a rotated and flattened view of the cutter mechanism taken along line 3C-3C of Figure 3A illustrating cutting segments thereof;

Figure 3D is a schematic cross sectional view of the cutter mechanism taken along line 3D of Figure 3C illustrating a cutting segment thereof;

Figure 3E is a schematic cross sectional view of the cutter mechanism taken along line 3E of Figure 3C illustrating a cutting edge between adjacent cutting segments;

Figure 3F is a schematic cross sectional view of the cutter mechanism taken along line 3F-3F of Figure 3A illustrating a rotating gas plate thereof;

Figure 3G is a schematic side elevation view of the cutter mechanism with parts removed taken along line 3G-3G of Figure 3A illustrating a stationary end plate thereof;

Figure 4A is a schematic view of a gas discharge system of the system;

Figure 4B is a schematic view of a portion of the cutter mechanism illustrating a connection with the gas discharge system;

Figure 5 is a block diagram of a snack product fabrication system incorporating the system of Figures 1A-1B;

Figure 6A is an enlarged front elevation view of a snack product fabricated in accordance with the invention;

Figure 6B is a cross sectional view of the snack product taken along line 6B-6B of Figure 6A; and

Figure 6C is a cross sectional view of the snack product taken along line 6C-6C of Figure 6A.

Detailed Description of the Preferred Embodiments

Referring to Figures 1A-1B and 2A-2G, a system 10 for making shaped snack products (e.g., snack product 12A- Figure 6A) in accordance with the invention is illustrated.

The system 10 includes a cutter assembly 14 comprising a rotating cutter mechanism 26, a rotating back up roller 28, and a rotating brush 84. The cutter assembly 14 is configured to cut a dough sheet 16 (Figure 2A) into a plurality of separate dough pieces 18A-18D (Figure 2A). In the illustrative embodiment, the dough sheet 16 comprises two separate layers including a first dough layer 16A (Figure 2G) and a second dough layer 16B (Figure 2G). However, it is to be understood that the system 10 and process can be used with any dough sheet including single layer dough sheets and multi layer dough sheets.

In addition to the cutter assembly 14, the system 10 also includes a dough conveyor 20 configured to move the dough sheet 16 into the cutter assembly 14, and to move the cut dough pieces 18A-18D away from the cutter assembly 14. In addition, the system 10 includes a web scrap mechanism 22 configured to move a continuous web scrap 24 (Figure 2A) from the cutter assembly 14 with a selected orientation relative to the dough pieces 18A-18D. In addition to moving and orienting the web scrap 24, the web scrap mechanism 22 allows the separate dough pieces 18A-18D (Figure 2A) to more freely separate from the web scrap 24.

Referring to Figure 2B, the web scrap 24 includes patterns of openings 25 wherein the dough pieces 18A-18D have been removed. In Figure 2B, each opening 25 corresponds to two nested dough pieces 18A. Although only openings 25 for the dough pieces 18A are illustrated, the dough pieces 18B-18D will produce openings (not shown) corresponding to their shapes. In addition to the openings 25, the web scrap 24 includes connecting segments 27, which

comprise remnant portions of the dough sheet 16 (Figure 2A) following separation of the dough pieces 18A-18D.

Referring to Figures 2C-2F, the dough pieces 18A-18D are shown separately. A rabbit-shaped dough piece 18A is shown in Figure 2C. A duck-shaped dough piece 18B is shown in Figure 2D. A bird-shaped dough piece 18C is shown in Figure 2E. A cat-shaped dough piece 18C is shown in Figure 2F. However, these shapes are merely exemplary, and the dough pieces 18A-18D can be formed with any selected shape, such as animal, plant, human, vehicle, structure, and geographic shapes. Further, the dough pieces 18A-18D have intricate features including heads, ears, arms, legs, feet, tails and whiskers. However, these features are merely exemplary, and the dough pieces 18A-18D can be made with any selected feature.

In addition, the dough pieces 18A-18D have a selected height H, a selected width W, and selected feature widths FW. By way of example, the height H can be on the order of one to two inches, the width W can be on the order of a one fourth to one half inch, and the feature widths FW can be on the order of one sixteenth to one eight of an inch. Further, the connecting segments 27 (Figure 2B) on the web scrap 24 can have a width CW (Figure 2B) as small as about one tenth of an inch. However, these dimensions are merely exemplary, and the dough pieces 18A-18D can be made with any selected dimension.

Referring to Figure 3A, the cutter mechanism 26 comprises a cylindrical member having a selected length, and a selected diameter. By way of example, the length can be on the order of one to several feet, and the diameter D can be on the order of six to thirty inches. The cutter mechanism 26 includes a cylindrical mandrel 42 (Figure 3B), and a plurality of separate rings 32, attached to the mandrel 42. The cutter mechanism 26 also includes a

stationary port plate 34 at each end, and a rotating gas conduit plate 36 at each end.

The mandrel 42 includes cylindrical shafts 45 (Figure 3A) at each end, and a hollow interior portion 46. The shafts 45 on the mandrel 42 allow the cutter mechanism 26 to be supported on bearings of a support structure (not shown), and driven by a suitable drive mechanism (not shown), such as sprockets and chains.

Referring to Figure 3B, the mandrel 42 can be made of a metal, such as steel, stainless steel or bronze, and the rings 32 can be made of a plastic, metal or ceramic material. In addition, the rings 32 have inside diameters that are only slightly larger than an outside diameter of the mandrel 42, such that the rings 32 can be slid onto the mandrel 42. Further, a square key 49 attaches to mating keyways on the inside diameters of the rings 32, and on the outside diameter of the mandrel 42, such that the mandrel 42 and the rings 32 rotate in unison. In addition to transmitting rotary motion of the mandrel 42 to the rings 32, the key 49 also attaches and aligns the rings 32 on the mandrel 42.

Still referring to Figure 3B, the cutter mechanism 26 also includes cutting segments 40A-40D (Figure 3C) formed on the outside surfaces 51 of the rings 32, and configured to cut the dough sheet 16 (Figure 2A) into the dough pieces 18A-18D (Figure 2A). In addition, the cutter mechanism 26 includes gas conduits 50, which function to supply pressurized gas to the cutting segments 40A-40D, for ejecting the dough pieces 18A-18D from the cutting segments 40A-40D in a manner to be hereinafter described. The gas conduits 50 comprise circular openings in the rings 32 extending through the rings 32 and generally parallel to a longitudinal axis 53 (Figure 3A) of the cutter mechanism 26. In the illustrative embodiment, there are twenty-four

gas conduits 50 which are evenly spaced on a circle which bisects the thicknesses of the rings 32.

Referring to Figure 3C, a pair of adjacent rings 32 are shown in a flattened view. In the illustrative embodiment, there are twenty-one rings 32 on the cutter mechanism 26 arranged end to end on the mandrel 42, with their outer surfaces 51 forming a continuous outside surface of the cutter mechanism 26. In addition, each ring 32 has a width WR of about 2.646 inches, and an outside diameter OD (Figure 3A) of about 10.776 inches. Further, a spacing SR of the cutting segments 40A-40D on adjacent rings 32 is about 0.2719 inches. Again these dimensions are merely exemplary.

In the illustrative embodiment, the cutting segments 40A-40D have cartoon character shapes, with cutting segments 40A shaped as rabbits, cutting segments 40B shaped as birds, cutting segments 40C shaped as cats, and cutting segments 40D shaped as ducks. The width W and height H of the cutting segments 40A-40D correspond to the width W (Figure 2C) and height H (Figure 2C) of the dough pieces 18A-18D. In addition, a spacing S of the cutting segments 40A-40D corresponds to the width CW (Figure 2B) of the connecting segments 27 (Figure 2B) on the web scrap 24 (Figure 2B).

Referring to Figure 3D, a single cutting segment 40A is shown in cross section. The cutting segments 40A-40D comprise cups formed by shaped blades 54 on the outside surfaces 51 (Figure 3B) of the rings 32. Each cutting segment 40A-40D is a cup having a peripheral shape defined by a single continuous shaped blade 54. As the rings 32 preferably comprise plastic or metal, the shaped blades 54 can be formed in the rings 32 using a suitable process such as machining, routing, etching or molding.

The area between the blades 54 defines the cutting segments 40A-40D as cups, which are configured to form and

then temporarily retain the dough pieces 18A-18D. In Figure 3D, the area bounded by the blades 54 forms the dough pieces 18A (Figure 2C), and the openings 25 (Figure 2B) in the web scrap 24 (Figure 2B) for the dough pieces 18A. The area outside the blades 54 defines the connecting segments 27 (Figure 2B) of the web scrap 24 (Figure 2B).

As shown in Figure 3D, the shaped blades 54 have a depth D which corresponds to a thickness of the dough pieces 18A-18D (Figure 2A). By way of example, the depth D can be on the order of 0.05-0.25 inches or less. In addition, the shaped blades 54 include sharpened tips 55 having a width w on the order of about 1 to 10 mm.

The blades 54 are configured to cut through and press the dough sheet 16 (Figure 2A) towards the surface of the back up roller 28 (Figure 1A). To facilitate the cutting process, the back up roller 28 can be configured to float and apply an axial force as indicated by double headed arrow 88 in Figures 1A and 1B.

In addition to the sharpened tips 55, the blades 54 have stepped cutting edges 52 configured to cut and compress the edges of the dough pieces 18A-18D (Figure 2A) as the dough sheet 16 (Figure 2A) passes between the rotating cutter mechanism 26, and the rotating back up roller 28 (Figure 1B). The stepped cutting edges 52 thus shape the dough pieces 18A-18D in the X and Y directions, and also shape the peripheral edges of the dough pieces 18A-18D in the Z direction.

In the illustrative embodiment, each cutting edge 52 has a stepped portion 56 configured to compress the edges of the dough pieces 18A-18D (Figure 2A) against a resistance applied by the back up roller 28 (Figure 1B). Further, the stepped cutting edges 52 are angled inward towards the centers of the cutting segments 40A-40D, such that the cutting segments 40A-40D decrease in size as the depth D increases. Stated differently, the cutting

segments 40A-40D are largest near their outside areas and become smaller as the depth D increases. This shape also facilitates compression of the edges of the dough pieces 18A-18D, and permits the dough pieces 18A-18D to be more easily discharged from the cutting segments 40A-40D.

As shown in Figure 3C, some of the cutting segments 40A-40D are formed in nested pairs having common shaped blades 54C (Figure 3E). As shown in Figure 3E, the common shaped blades 54C include stepped cutting edges 52, which function to cut and compress the edges of the dough pieces 18A-18D (Figure 2)A, substantially as previously described.

As shown in Figure 3D, each cutting segment 40A-40D includes one or more gas ports 48 in flow communication with the gas conduits 50 (Figure 3B) located within the cutter mechanism 26. The gas ports 48 comprise cylindrical openings through the material of the rings 32 to the gas conduits 50 (Figure 3B) within the rings 32. The gas ports 48 can be perpendicular to a central axis of the cutting segments 40A-40D, or can be angled with respect to the cutting segments 40A-40D.

The gas ports 48 are configured to direct a pressurized gas, such as air, at the dough pieces 18A-18D (Figure 2A) contained within the cutting segments 40A-40D. The pressurized gas functions to discharge the dough pieces 18A-18D from the cutting segments 40A-40D onto the dough conveyor 20 (Figure 2A). In addition, the pressurized gas functions to clean out obstructed or plugged gas ports 48 during a clean out cycle of the cutter mechanism 26.

Referring to Figure 3F, the cutter mechanism 26 also includes the gas conduit plates 36 on each end, which are attached to the mandrel 42 (Figure 3B) for rotation therewith. Each gas conduit plate 36 includes an opening 37 for the shaft 45 (Figure 3A) on the mandrel 42 (Figure 3B). Each gas conduit plate 36 also includes a plurality

of gas openings 38 aligned with and in flow communication with the gas conduits 50 through the cutter mechanism 26.

Referring to Figure 3G, the cutter mechanism 26 also includes the port plates 34 at each end, which are fixed relative to the rotating mandrel 42 (Figure 3B) and the rotating gas conduit plates 36 (Figure 3F). Each port plate 34 includes an opening 46 for the shaft 45 (Figure 3A) on the mandrel 42 (Figure 3B). Each port plate 34 also includes a discharge port 74 and a clean out port 76. The discharge ports 74 and the clean out ports 76 are configured to direct pressurized gas through the gas openings 38 in the gas conduit plates 36, and through the gas conduits 50 (Figure 3B) in the cutter mechanism 26 to the gas ports 48 (Figure 3D) in the cutting segments 40A-40D (Figure 3C).

As the cutter mechanism 26 rotates, each of the gas openings 38 (Figure 3F) on the gas conduit plates 36 (Figure 3F) comes into alignment with the discharge ports 74, and then with the clean out ports 76 on the stationary port plates 34. The discharge ports 74 are located at an angle D selected to optimize the location of the discharge point D (Figure 2A) of the dough pieces 18A-18D from the cutting segments 40A-40D. In Figure 3G, the three o'clock position on the circular port plate 34 has been designated as zero. A representative value for the angle A for the discharge ports 74, measured from the three o'clock position, can be from about 275° to 285°. A representative value for the angle B for the clean out ports 76, measured from the three o'clock position, can be from about 10-20°.

Referring to Figure 4A, the system 10 also includes a gas discharge system 58 configured to provide pressurized gas to the discharge ports 74 (Figure 3G) on the port plates 34 for discharging the dough pieces 18A-18D (Figure 2A) from the cutting segments 40A-40D (Figure 3C). The gas discharge system 58 is also configured to provide

pressurized gas to the clean out ports 76 on the port plates 34, which is directed through the gas conduits 50 to the gas ports 48 in the cutting segments 40A-40D to remove any obstructions (e.g., dough plugs) from blocked or plugged gas ports 48.

The gas discharge system 58 includes a gas source 60, and an accumulation tank 62 in flow communication with the gas source 60. The gas source 60 can comprise a pressurized air source, such as a plant air supply. The accumulation tank 62 can comprise a sealed receiver having a required internal volume. The gas discharge system 58 also includes a pressure regulator valve 64 in flow communication with the accumulation tank 62, and with discharge lines 66. The discharge lines 66 are in flow communication with the discharge ports 74 (Figure 3G) on the port plates 34. The regulator valve 64 is configured to adjust the gas pressure, such that the dough pieces 18A-18D discharge cleanly from the cutting segments 40A-40D.

The gas discharge system 58 also includes a clean out valve 68 in flow communication with clean out lines 70. The clean out lines 70 are in flow communication with the clean out ports 76 (Figure 3G) on the port plates 34. The clean out lines 70 are configured to provide pressurized gas for removing obstructions (e.g., dough plugs) from the gas ports 48. In addition, the clean out valve 68 is in signal communication with a manual activation switch 72, such that manual cleaning can be performed.

Referring to Figure 4B, further details of the gas discharge system 58 are illustrated. The discharge lines 66 are attached to discharge fittings 80 on the stationary port plates 34. The discharge fittings 80 are in flow communication with the discharge ports 74 on the port plates 34, which as previously explained sequentially communicate with the gas openings 38 on the gas conduit plates 36. The clean out lines 70 are attached to clean

out fittings 82 on the stationary port plates 34. The clean out fittings 82 are in flow communication with the clean out ports 76, which as previously explained sequentially communicate with the gas openings 38 on the gas conduit plate 36. As also shown in Figure 4B, seals 78 are positioned between the stationary port plate 34 and the rotating gas conduit plate 36.

Referring to Figure 2A, the cutter mechanism 26 also includes a brush 84 configured to remove dough pieces 18A-18D, or portions thereof, from the cutter mechanism 26 that do not cleanly discharge from, or clean out of the cutting segments 40A-40D (Figure 3C) during the clean out cycle. The brush 84 can comprise a plurality of bristles made of a flexible material such as nylon. In addition, the brush 84 can be mounted proximate to the cutter mechanism 26 for counter rotation imparted by rotation of the cutter mechanism 26. The dough pieces 18A-18D, or portions thereof, removed by the brush tend to fall on the moving web scrap 24.

Referring to Figures 1A and 1B, the web scrap mechanism 22 will be described in greater detail. In the illustrative embodiment, the web scrap mechanism 22 comprises an endless conveyor belt 90 mounted on rollers 92. At least one of the rollers 92 is driven by a suitable drive mechanism to move the conveyor belt 90 as indicated by directional arrow 98. In addition, a movable roller 94 is connected to a hydraulic mechanism (not shown), and is configured to position the web scrap mechanism 22 in "Position 1" shown in Figure 1A, "Position 2" in Figure 1B, or any position between "Position 1" and "Position 2".

In general, "Position 1" can be used for separating dough pieces 18A-18D (Figure 2A) having a relatively large size (e.g., 2 inch diameter ovals), and when the web scrap 24 has a relatively small proportion relative to the uncut dough sheet 16 (e.g., 5%-35%). Position 2, can be used for

separating small dough pieces 18A-18D (Figure 2A), and when the web scrap 24 has a relatively large proportion relative to the uncut dough sheet 16 (e.g., 30%-60%). Position 1 can also be used at the start up of a process for separating dough pieces 18A-18D (Figure 2A), and Position 2 used after a steady state has been reached.

In Position 1, the conveyor belt 90 of the web scrap mechanism 22 is spaced from the cutter mechanism 26 by a relatively large distance (e.g., 4 inches to 8 inches from edge of belt 90 to edge of cutter mechanism). Also in Position 1, the web scrap 24 is pulled from the cutter mechanism 26 by the conveyor belt 90 with a relatively shallow angular orientation (e.g., 5° to 25° from a horizontal plane). In Position 2, the conveyor belt 90 of the web scrap mechanism 22 is spaced from the cutter mechanism 26 by a relatively small distance (e.g., one inch to 3 inches). Also in Position 2, the web scrap 24 is pulled from the cutter mechanism 26 by the conveyor belt 90 with a relatively large angular orientation (e.g., 25° to 75° from a horizontal plane).

The conveyor belt 90 of the web scrap mechanism 22 can comprise a material such as urethane or rubber, capable of exerting a pulling force F (Figure 2A) on the web scrap 24. Suitable conveyor belts are commercially available from Falcon Belting Inc., of Oklahoma City, OK. A width of the conveyor belt 90 can be slightly larger than the width of the web scrap 24 (e.g., one inch to two inches greater on each side). A conveying length of the conveyor belt 90 can be on the order of one to two feet in Position 1, and three to six feet in Position 2. A speed of the conveyor belt 90 can be from 1-2% faster than the speed of the cutter assembly 14 and the dough conveyor 20. A representative speed of the conveyor belt 90 can be from four feet/minute to 100 feet/minute.

As also shown in Figures 1A and 1B, a cross conveyor 96 is positioned generally orthogonal to the web scrap mechanism 22. The cross conveyor 96 is configured to receive the web scrap 24 from the web scrap mechanism 22, and to convey the web scrap 24 to a desired location (e.g., recycle point). The cross conveyor 96, and the dough conveyor 20 as well, can include conveyor belts formed of a material such as urethane or rubber, and can include suitable mounting rollers (not shown).

Referring to Figure 2A, during operation of the system 10 the uncut dough sheet 16 is conveyed by the dough conveyor 20 into the cutter mechanism 26. As the cutter mechanism 26 rotates counter clockwise as indicated by directional arrow 99, the row of cutting segments 40A-40D at the 270° position contact the dough sheet 16 and cut the dough pieces 18A-18D. Following these particular cutting segments 40A-40D, between the 270° position and the D discharge position of the cutter mechanism 26, the dough pieces 18A-18D are retained in these particular cutting segments 40A-40D. By way of example, the D discharge position can be located at an angle between about 275° to 285° measured from the three o'clock point of the counter rotating cutter mechanism 26.

At the D discharge position of the cutter mechanism 26, the discharge ports 74 (Figure 3G) in the port plates 34 (Figure 3G) allow pressurized gas to flow through the gas openings 38 (Figure 3F) in the gas conduit plate 36 (Figure 3F), and through the gas conduits 50 (Figure 3B) associated with these cutting segments 40A-40D. The pressurized gas is directed through the gas ports 48 in the cutting segments 40A-40D and ejects the dough pieces 18A-18D out of the cutting segments 40A-40D and onto the dough conveyor 20.

Also at the D discharge position of the cutter mechanism 26, the web scrap 24 is moved by the web scrap

mechanism 22 and oriented at an angle relative to the dough pieces 18A-18D. The movement and angular orientation of the web scrap 24 moves the connecting segments 27 (Figure 2B) on the web scrap 24 away from the dough pieces 18A-18D, such that they can be easily separated from the cutting segments 40A-40D, and from the openings 25 (Figure 2B) in the web scrap 24, by the pressurized gas. At the same time, the separated dough pieces 18A-18D are moved by the dough conveyor 20 away from the cutter mechanism 26. In addition, the web scrap mechanism 22 exerts a force F on the web scrap 24, and slightly stretches the web scrap 24. The separation of the dough pieces 18A-18D from the web scrap 24 is thus performed by the combination of gas pressure on the dough pieces 18A-18D, movement of the web scrap 24 away from the dough pieces 18A-18D, angular orientation of the web scrap 24 relative to the dough pieces 18A-18D, and movement of the dough pieces 18A-18D away from the web scrap 24. This separation process allows small intricately shaped dough pieces 18A-18D to be removed efficiently and with minimal damage to the dough pieces 18A-18D.

At the C clean out position of the cutter mechanism 26, the clean out ports 76 (Figure 3G) in the port plates 34 (Figure 3G) allow pressurized gas to flow through the gas openings 38 (Figure 3F) in the gas conduit plate 36 (Figure 3F), and through the associated gas ports 48 in the cutting segments 40A-40D to clean out obstructed or plugged gas ports 48. Any partial dough pieces, such as dough plugs, drop onto the web scrap 24 and travel with the web scrap 24 to the cross conveyor 96 (Figure 1A). The brush 84 also helps to separate any partial dough pieces from the cutter mechanism 26.

Referring to Figure 5, a snack product fabrication system 100 incorporating the system 10 of Figures 1A-1B, is illustrated. In addition to the system 10, the snack

product fabrication system 100 includes a mixing system 102 configured to mix ingredients to form a dough 114, a sheeting system configured to sheet the dough 114 into the dough sheet 16, a cooking system 110 configured to cook the dough pieces 18A-18D into a plurality of snack products 12A-12D, and a packaging system 112 configured to package the snack products 12A-12D into packages 116.

The mixing system 102 can include one or more storage containers 104 configured to store ingredients for making the dough 114. The mixing system 102 can also include a mixer 106 configured to mix the ingredients with an appropriate quantity of water. Suitable mixers are commercially available from Stephan Machinery Corporation of West Germany, and Hobart Corporation of Troy, OH, as well as others.

The dough ingredients can include conventional starch-containing foods traditionally used to make snack products. US Patent No. 4,756,920 to Willard, US Patent Nos. 4,889,733 and 4,889,737 to Willard et al., US Patent Nos. 4,931,303 and 4,994,295 to Holm et al., and US Patent No. 5,366,749 to Frazee et al., all of which are incorporated herein by reference, describe various dough formulations.

In the illustrative embodiment, potato flakes, corn flour and water are the main ingredients of the dough 114. However, the dough 114 can also include other ingredients, such as raw or pre-gelatinized starches, modified starches, flavorings, oils, preservatives and whole cereal grains. These ingredients are mixed with an appropriate quantity of water to achieve a desired dough consistency having a moisture content of from about 35% to 60%.

The sheeting system 108 can comprise one or more pairs of sheeting rolls configured to compress the dough 114 into the dough sheet 16. Dough rollers are widely used in the manufacture of conventional sheeted snack products and are commercially available from Reading Bakery Systems of

Robesonia, PA, as well as others. Rather than rollers, the sheeting system 108 can include conventional extruders or presses suitable for making the dough sheet 16. By way of example, the dough sheet 16 can have a thickness in the range of about 0.5 mm to about 1.5 mm.

The dough sheet 16 can be fed into the system 10 (Figures 1A-1B) to form the dough pieces 18A-18D, substantially as previously described. In addition, the web scrap 24 can be combined with the dough 114 prior to introduction into the sheeting system 108.

The cooking system 110 is configured to cook the dough pieces 18A-18D into the snack products 12A-12D. In the illustrative embodiment, the cooking system 110 comprises a frying system having a bath containing cooking oil at an elevated temperature (e.g., 325°F (165°C) to 400°F. (205°C). The dough pieces 18A-18D can be fried for a time period sufficient to produce a final moisture content of about 1-2%. A frying system can also include mechanisms such as submerging belts, nozzles and wires configured to submerge the dough pieces 18A-18D in the cooking oil. Suitable cooking systems are commercially available from Heat and Control Inc. of Hayward, CA, as well as others.

The packaging system 112 is configured to package the snack products 12A-12D into packages 116. The packaging system 112 can comprise conventional packaging equipment used in the snack product industry. Suitable packaging systems are commercially available from Heat and Control Inc. of Hayward, CA, as well as others.

The snack product fabrication system 100 can optionally include a dockering system configured to docker the dough sheet 16 or the dough pieces 18A-18D to reduce bubbles or pillows that can form in fried snack products. One such dockering system is described in US Patent No. 4,889,737 to Willard et al., which is incorporated by reference.

Referring to Figures 6A-6C, a shaped snack product 12A fabricated using the fabrication system 100 is illustrated. The shaped snack product 12A was made from the dough sheet 16 having the first dough layer 16A (Figure 2G) and the second dough layer 16B (Figure 2G). The dough piece 18A (Figure 2C) for making the snack product 12A had these same two layers (dough layers 16A and 16B in Figure 2G).

The snack product 12A includes a first cooked dough layer 118A, which corresponds to the first dough layer 16A (Figure 2G), and a second cooked dough layer 118B, which corresponds to the second dough layer 16B (Figure 2G). The cooked dough layers 16A, 16B terminate at a continuous shaped edge 120, which defines the outer periphery of the snack product 12A. In addition, the continuous shaped edge 120 and the outer surfaces of the cooked dough layers 16A, 16B forms an enclosed, sealed chamber 122.

Recall that the continuous shaped edge 120 of the cooked dough layers 16A, 16B has been compressed and sealed by the stepped cutting edge 52 (Figure 3D) on the particular cutting segment 40A which formed the dough piece 18A. The shaped edge 120 completely encircles the outer periphery of the snack product 12A, and can be described as a crimped and sealed edge. During cooking of the dough piece 18A, gases are trapped between the dough layers 16A, 16B forming the chamber 122. However, the shaped edge 120 is able to resist deformation by the gases, such that the chamber 122 has a curved or bulging outside surface. The chamber 122 can thus be described as having been formed by "controlled pillowing" using two dough layers 16A, 16B having a continuous shaped edge 120.

The snack product 12A can be described as having a three dimensional shape similar to a molded plastic toy, such as a small soldier. In addition, the snack product 12A can be described as having a bulging center portion 124 (Figure 6A), as the chamber 122 has curved outside surfaces

formed by a single cooked dough layer 118A or 118B. Further, an edge thickness TE of the snack product 12A proximate to the shaped edge 120 is close to the original thickness of the dough sheet 16 (Figure 2G). This edge thickness TE makes intricate features, such as the ears and feet of the snack product 12A, as relatively rigid structures, because they are primarily formed by the shaped edge 120. Still further, as the shaped edge 120 includes portions of both cooked dough layers 118A, 118B it has a double thickness, which provides a rigid outer support structure for the snack product 12A, and a crunchy volume of cooked dough during consumption of the snack product 12A.

In contrast, a center thickness TC of the center portion 124 (Figure 6A) of the snack product 12A can be several times greater than the edge thickness TE. By way of example, if the snack product 12A is made from a dough piece 18A (Figure 2C) having a height H of 40.5 mm, a width of 18.5 mm, and a thickness of 1.35 mm, a representative range for the edge thickness TE can be from 0.8 mm to 1.35 mm, a representative range for the center thickness TC can be from 4.5 mm to 7.0 mm, and a representative range for an edge width WE can be from 0.5 mm to 2.5 mm.

Thus the invention provides a process and a system for making shaped snack products, and a snack product fabricated using the process and system. Although the invention has been described with reference to certain preferred embodiments, as will be apparent to those skilled in the art, certain changes and modifications can be made without departing from the scope of the invention, as defined by the following claims.